

Kings River Water Quality Coalition

# Comprehensive Groundwater Quality Management Plan Annual Report

**Reporting Period:**

**January 1, 2018 through December 31, 2018**

Fresno, Kings and Tulare Counties, California

Submitted: September 3, 2019





# Table of Contents

Table of Contents .....	ii
List of Figures.....	iii
List of Tables .....	iii
Abbreviations.....	iv
Executive Summary.....	1
Comprehensive Groundwater Quality Management Plan Annual Report Overview .....	1
1    Introduction.....	1-3
2    Management Practices Evaluation Program (MPEP).....	2-1
3    Actions to Address Groundwater Quality Objectives .....	3-1
3.1    Identification of potentially impairing and protective management practices.....	3-1
3.2    Evaluation and tracking of current management practices.....	3-4
3.3    Education and outreach for members on management practices and impacts.....	3-7
3.4    Implementation and verification of protective management practices.....	3-8
3.5    Monitoring to determine if management practices are resulting in improved groundwater quality .....	3-11
4    Recommendations and Conclusions.....	4-13
4.1    Outreach in High Vulnerability Areas .....	4-13
4.2    Destruction of Abandoned Wells.....	4-13
4.3    Wellhead Protection .....	4-14
4.4    Chemigation/Fertigation Practices .....	4-14
4.5    Nitrogen Outliers.....	4-14
4.6    Conversion of Management Practices .....	4-15
5    Bibliography/References .....	5-1
Appendix A.....	5-1
MPEP Annual Update .....	5-1



## List of Figures

Figure 3-1. Irrigation Wellhead Protection Measures .....	3-5
Figure 3-2. Abandoned Well-Destroyed Method.....	3-6
Figure 3-3. 2018 Primary Irrigation Management Practices.....	3-7

## List of Tables

Table 1-1. Actions, Performance, Metrics, and Goals for the KRWQC CGQMP .....	1-4
Table 2-1. Summary of KRWQC CGQMP MPEP Activities and Corresponding Status .....	2-1
Table 3-1. Irrigation Practices and Considerations for Adoption.....	3-2
Table 3-2. Abandoned Well Data from Farm Evaluations 2016-2018.....	3-9
Table 3-3. Protective Practice Adoption Responses for Abandoned Wells, 2016-2018.....	3-10
Table 3-4. Protective Practice Adoption Responses for Active Wells, 2016-2018 .....	3-10
Table 3-5. Grower Reported Responses to Nitrate-N Testing of Irrigation Water 2016-2018.....	3-10
Table 3-6. Primary Irrigation System, 2016-2018.....	3-10



## Abbreviations

A/R	Applied Nitrogen over Removed Nitrogen
A/Y ratio	Applied Nitrogen divided by Yield
AGR	Agricultural
Annual Report	Comprehensive Groundwater Quality Management Plan Annual Report
BMP	Best Management Practice
CDFA	California Department of Food and Agriculture
CGQMP	Comprehensive Groundwater Quality Management Plan
Coalition	Kings River Water Quality Coalition
COC	Constituents of Concern
CVGMC	Central Valley Groundwater Monitoring Collaborative
FE	Farm Evaluation Survey
FREP	Fertilizer Research and Education Program
GAR	Groundwater Assessment Report
General Order	General Order R2013-0120-07
GQTM	Groundwater Quality Trend Monitoring
HVA	High Vulnerability Area
ILRP	Irrigated Lands Regulatory Program
INMP	Irrigation and Nitrogen Management Plan
IQR	Interquartile Range
KRWQC	Kings River Water Quality Coalition
MPEP	Management Practice Effectiveness Program
KRWQC	Kings River Water Quality Coalition
MRP	Monitoring and Reporting Program
MUN	Municipal and Domestic
QAPP	Quality Assurance Project Plan
N	Nitrogen
NMP	Nitrogen Management Plan
NO3	Nitrate
Q	Quartile
Regional Board	Central Valley Regional Water Quality Control Board
SSJV	Southern San Joaquin Valley



SSJVWQC..... Southern San Joaquin Valley Water Quality Coalition  
SWAT .....Soil and Water Assessment Tool  
UCCE .....University of California Cooperative Extension  
USDA .....United States Department of Agriculture



# Executive Summary

The Comprehensive Groundwater Quality Management Plan (CGQMP) Annual Report (Annual Report) has been prepared to meet the requirements of the Irrigated Lands Regulatory Program (ILRP). The Kings River Water Quality Coalition (KRWQC or Coalition) has been approved by the Executive Officer as a third-party group in compliance with Waste Discharge Requirements, General Order for Growers in the Tulare Lake Basin that are Members of a Third-Party Group, Order No. R5-2013-0120-07 (General Order). The KRWQC was formed in 2012 as one of four sub-watersheds, formerly part of the Southern San Joaquin Valley Water Quality Coalition (SSJVWQC).

The Coalition's Comprehensive Groundwater Quality Management Plan (CGQMP) was conditionally approved on November 1, 2017 and the CGQMP Amendment was submitted on January 12, 2018 (approval pending). The elements of the CGQMP are to A) investigate potential irrigated agricultural sources of waste discharge to groundwater, B) review physical setting information for the plan area such as geologic factors and existing water quality data, C) considering elements A and B, develop a strategy with schedules and milestones to implement practices to ensure discharge from irrigated lands are meeting Groundwater Receiving Water Limitation III.B, D) develop a monitoring strategy to provide feedback on CGQMP progress, E) develop methods to evaluate data collected under the CGQMP, and F) provide reports to the Central Valley Regional Water Quality Control Board (Regional Board) on progress. The Comprehensive Groundwater Quality Management Plan Annual Report (Annual Report), element F, discusses the annual progress for schedules and milestones for implementation practices (element C), provides feedback on progress (element D), and evaluates data collected under the CGQMP (element E).

## Comprehensive Groundwater Quality Management Plan Annual Report Overview

Included in this CGQMP Annual Report are the requirements described in the CGQMP:

1. MPEP Practices Evaluation Program (MPEP): The MPEP Workplan submitted in Fall 2017 describes the planning and implementation of tasks necessary to demonstrate to the Regional Board which agricultural management practices are effective in protecting water quality, and how these practices have been or will be implemented to affect this protection. Requirements under that CGQMP that are conducted as part of the MPEP are summarized in the Annual Report and the MPEP Annual Update is included as Appendix A.
2. Actions to Address Groundwater Quality: Actions taken by the KRWQC to address groundwater quality objectives through the Farm Evaluation Survey (FE), Nitrogen Management Plan (NMP) Summary Report, outreach, and monitoring are addressed in the CGQMP Annual Reporting including:
  - a. Identification of potentially impairing and protective management practices
  - b. Evaluation and tracking of current management practices
  - c. Education and outreach for members on management practices and impacts
  - d. Implementation and verification of protective management practices
  - e. Monitoring to determine if management practices are resulting in improved groundwater quality



3. Recommendations and Conclusions: Details of the current status of the performance goals with recommendations and conclusions through actions and performance metrics.
  - a. Outreach in High Vulnerability Areas: Annually, KRWQC members are mailed information packets which includes member parcels, vulnerability status, templates, submittal deadlines, and annual fees. Sixty-three percent of KRWQC members attended outreach events in 2018.
  - b. Destruction of Abandoned Wells: While the Coalition continues to discuss proper well abandonment requirements in annual outreach events, it is believed that a more aggressive outreach will assist in additional abandonment compliance.
  - c. Wellhead Protection: The Coalition continues to discuss proper well protection requirements in annual outreach events, but it is believed that a more aggressive outreach will assist in additional wellhead protection compliance.
  - d. Chemigation/Fertigation Practices: Approximately 24.8% of Coalition members are currently utilizing chemigation practices in their farming operations. Approximately 64.6% of Coalition members are currently utilizing Fertigation practices in their farming operations. The Coalition will conduct additional surveys, outreach, and technical workshops on chemigation and fertigation practices.
  - e. Nitrogen Outliers: Revisions adopted to the General Order in February 2019, require that the KRWQC propose an approach (by December 31, 2019) for defining a set of Members (outliers) with whom the third-party will follow up annually based on the new Irrigation and Nitrogen Management Plan (INMP) Summary Report data (AR data). Members in KRWQC will first report their INMP Summary Report data for calendar year 2020. The Coalition is currently analyzing submitted NMP Summary report data for years 2016-2018 to identify consistent outliers (if any).
  - f. Conversion of Management Practices: Collection, application, and research on management practices that result in further protection of groundwater are goals of the MPEP activities. The Coalition continues to communicate to members via newsletters, outreach events, and educational pamphlets about the most effective management practices for groundwater protection.



# 1 Introduction

The Kings River Water Quality Coalition (KRWQC or Coalition) has been approved to serve as the third-party representative for Order R2013-0120-07 Waste Discharge Requirements General Order for Growers within the Tulare Lake Basin Area that are Members of a Third-Party Group (General Order). The Coalition's Comprehensive Groundwater Quality Management Plan (CGQMP) was conditionally approved on November 1, 2017 and the CGQMP Amendment was submitted on January 12, 2018 (approval pending). The General Order allows for the submittal of a CGQMP, in lieu of submitting separate management plans, that will evaluate the effectiveness of management practices in protecting water quality. The main elements of the CGQMP are to A) investigate potential irrigated agricultural sources of waste discharge to groundwater, B) review physical setting information for the plan area such as geologic factors and existing water quality data, C) considering elements A and B, develop a strategy with schedules and milestones to implement practices to ensure discharge from irrigated lands are meeting Groundwater Receiving Water Limitation III.B, D) develop a monitoring strategy to provide feedback on CGQMP progress, E) develop methods to evaluate data collected under the CGQMP, and F) provide reports to the Central Valley Regional Water Quality Control Board (Regional Board) on progress. The Comprehensive Groundwater Quality Management Plan Annual Report (Annual Report), element F, discusses the annual progress for schedules and milestones for implementation practices (element C), provides feedback on progress (element D), and evaluates data collected under the CGQMP (element E).

The stated objectives of the CGQMP include:

- Protection of identified surface water beneficial uses,
- Increased awareness of issues associated with excessive nitrogen (N) application,
- Improving water management such that applied N is kept within the active root zone by limiting the amount of water available for leaching or changing the time of N applications,
- Improving Nitrogen Use Efficiency in that more of the applied N is used by the crop and the amount of residual N (N surplus) in the soil profile is minimized without adverse effects on crop yields, and
- Promoting the adoption of demonstrated successful practices to all growers within the KRWQC service area.

The Management Practice Effectiveness Program (MPEP) will be utilized to identify the effectiveness of management practices, where there is uncertainty regarding practice effectiveness under different site conditions. Collection, application, and research on management practices that result in further protection of groundwater are goals of the MPEP activities. Further discussion on current and future MPEP activities can be found under the MPEP section of this Annual Report and the MPEP Annual Update (Appendix A). The Coalition's efforts under the General Order includes the participation in the development and implementation of the MPEP, the collection, evaluation, and reporting of Farm Evaluation Survey (FE) and Nitrogen Management Plan (NMP) Summary Report data, and the selection and monitoring of shallow groundwater wells for the Basin-wide Groundwater Quality Trend Monitoring (GQTM) efforts as part of the Central Valley Groundwater Monitoring Collaborative (CVGMC). These assorted programs, in combination with outreach activities, provide the basis for improving surface management practices that will, eventually, result in improvements to groundwater quality. Grower adoption of protective management practices, where necessary, to protect groundwater, is the goal of the Coalition's outreach activities. Actions that will be undertaken to meet the objectives of the GQMP include:

- Identification of potentially impairing and protective management practices





## Section One: Introduction

### Comprehensive Groundwater Quality Management Plan Annual Report

- Evaluation and tracking of current management practices
- Education and outreach for members on management practices and impacts
- Implementation and verification of protective management practices
- Monitoring to determine if management practices are resulting in improved groundwater quality.

The Coalition will evaluate the effectiveness of the CGQMP strategy through the actions, performances metrics, and goals as presented in Table 1-1.

**Table 1-1. Actions, Performance, Metrics, and Goals for the KRWQC CGQMP**

Performance Goal	Action	Metric	Goal	Completion Date	Deliverable
<b>Outreach in High Vulnerability Area (HVA)</b>					
	Define HVA	List of parcels	100%	Completed	Invoicing
	Outreach	Attendance	100%	On-going	Annual Report / Membership lists
<b>Destruction of Abandoned Wells</b>					
	Locate Parcels with Abandoned Wells	Map Completion	100%	180 days after CGQMP Approval	Map with Annual Report
	Outreach	Increase in destroyed wells, reduction in abandoned wells	100%	5 years after CGQMP Approval	Annual Report Tracking
<b>Wellhead Protection</b>					
	Outreach	Change in Part B reporting	100% of reported wells having all boxes checked	5 years after CGQMP approval	Annual Report Tracking
<b>Chemigation/Fertigation Practices</b>					
	Outreach and Surveys	Reported adoption of backflow prevention practices	100%	5 years after CGQMP Approval	Annual Report Tracking
<b>Nitrogen Outliers</b>					
	Identification of Consistent Outliers	List of outliers in consecutive years or multiple times in 3-to-5 year period	100% Identification, Elimination is Statistically Impossible	5 years after CGQMP	Annual Report Tracking
	Outreach to Outliers	# of Growers Reached	100%	Yearly, Beginning in Year 3	Annual Report Tracking
<b>Conversion of Management Practices</b>					
	Identification of Protective Practices	Change in Farm evaluation reporting of irrigation practices	100% Adoption	5-8 Years After MPEP Workplan Approval	MPEP and Farm Evaluation Data, Annual Report Tracking
	Outreach	Attendance of outreach events	100%	Yearly	Annual Report Tracking



## 2 Management Practices Evaluation Program (MPEP)

General Orders for irrigated lands focus on controlling nitrate (NO<sub>3</sub>) contamination of groundwater by irrigated agriculture, and require a Management Practices Evaluation Program (MPEP) to evaluate and demonstrate which management practices are effective in protecting water quality, and how their implementation on the landscape effects this protection. Under a Coordination Agreement dated November 18, 2014, and updated in November 2015, the following Coalitions agreed to implement the MPEP through the Group Option organized as the Southern San Joaquin Valley (SSJV) MPEP Committee: Kings River Water Quality Coalition, Tule Basin Water Quality Coalition, Kaweah Basin Water Quality Association, Kern River Watershed Coalition Authority, Cawelo Water District Coalition, Westside Water Quality Coalition, and Buena Vista Coalition. The MPEP Workplan submitted in Fall 2017 describes the planning and implementation of tasks necessary to demonstrate to the Regional Board which agricultural management practices are effective in protecting water quality, and how these practices have been or will be implemented to affect this protection. The SSJV MPEP Committee Workplan is available here:

[https://agmpep.com/mpep/wp-content/uploads/20170914\\_Final\\_SSJV\\_MPEP\\_Workplan.pdf](https://agmpep.com/mpep/wp-content/uploads/20170914_Final_SSJV_MPEP_Workplan.pdf).

Table 2-1 summarizes requirements under the CGQMP that are conducted as a part of the MPEP including a summary of the CGQMP activity, the corresponding MPEP activity, and a reference to where additional information is described in the MPEP Annual Update (Appendix A) which describes activities from the beginning of MPEP activities through May 2019. The MPEP Annual Report (Appendix A) summarizes the SSJV MPEP activities with emphasis on work-planning and fundraising, assessments, priority investigations/studies, outreach, reporting, and other regulatory activities related to the MPEP.



**Section Two: Management Practices Evaluation Program**  
 Comprehensive Groundwater Quality Management Plan Annual Report

**Table 2-1. Summary of KRWQC CGQMP MPEP Activities and Corresponding Status**

Section Number	Section Title	Page Number	Category of Proposed Action	CGQMP Text	Corresponding MPEP Activity	Corresponding Section of MPEP Annual Update
5.3	Implementation Strategy	43/147	MPEP Research	CGQMP implementation will be integrated with SSJV MPEP activities and other ILRP elements to address groundwater quality impacts. The KRWQC will leverage the ongoing efforts of the SSJV MPEP to compile background information for management practices, facilitate training programs, and produce outreach and educational materials appropriate to protective management practices.	Pertains to most MPEP assessment, study, and outreach activities.	MPEP assessment and study activities are described in Section 2.3, Appendix E, and Appendix G. Outreach activities are described in Section 2.4, Appendix H, and Appendix I.
5.3.1	Partner Agencies and Entities	44/147	MPEP Collaboration	The missions of institutions and programs such as the UCCE, ITRC, and FREP make them ideal partner organizations to help accomplish the objectives of the CGQMP. Existing training programs and outreach materials developed by these partners will be employed to the greatest extent possible. This will allow KRWQC to benefit from the knowledge and expertise of existing programs, while contributing to expansion of the knowledge base through the SSJV MPEP. Additional research objectives for specific cropping systems will likely be achieved in partnership with commodity groups that are dedicated to providing access to information on effective field level management practices to improve production and efficiency.	In addition to groups listed, coalitions are engaging NRCS and CSU Fresno's Center for Irrigation Technology (CIT) as outreach partners. Several new tools to help growers plan irrigation and fertilization have been brought online, all with partner participation as co-developers or reviewers. Commodities groups are key because they have high levels of credibility with their grower communities.	New tools are described in Section 2.4.2.
5.3.2.1	Practices to Reduce Deep Percolation of COCs	44/147	MPEP Research	The SSJV MPEP also identifies protective practices. These practices limit deep percolation of COCs. Where there is uncertainty about management practice performance, or where new knowledge is needed, the SSJV MPEP initiates investigations to close these knowledge gaps or develops needed tools.	The MPEP is working with collaborators in the scientific research community to understand practices' effect on the recovery of applied N, and what prevents some growers from adopting practices. We are co-principal investigators on numerous projects, and principal investigators on several.	A summary of projects pursued with the scientific research community to understand practices' effect on the recovery of applied N is provided in Appendix A. A summary of the MPEP study to assess what prevents some growers from adopting practices is provided in Section 2.3.3 and Attachment G.
5.3.2.1	Practices to Reduce Deep Percolation of COCs	44/147	MPEP Collaboration	As part of early outreach, the SSJV MPEP Team is working with CDFA, UCCE, and other partners to inventory known protective management practices. The SSJV MPEP will promote expanded practice implementation, and continue to work to develop and validate protective practices.	The list of protective practices provided in the MPEP Workplan (based on another developed by UC) is the current, working list. It will be updated during the course of the MPEP. However, it is unlikely that major practices will be added. Rather, we may add some details, such as where certain practices provide the greatest benefit. For example, our work with growers and the research community suggests that improving the operation of existing drip and microspray irrigation and fertigation equipment, with a relatively minor addition of monitoring and control infrastructure, may improve N recovery into marketable yield over a very large acreage. These operations therefore become a focus area.	A summary of projects pursued with the scientific research community to understand practices' effect on the recovery of applied N is provided in Appendix A. A summary of an MPEP study to assess irrigation and fertilization is provided in Section 2.3.2.



## Section Two: Management Practices Evaluation Program

Comprehensive Groundwater Quality Management Plan Annual Report

Section Number	Section Title	Page Number	Category of Proposed Action	CGQMP Text	Corresponding MPEP Activity	Corresponding Section of MPEP Annual Update
5.3.2.3	Technically and Economically Feasible Practices	45/147	Coalition Outreach	The KRWQC will seek to mitigate barriers to adoption which are within the scope of the Coalition. Activities to address implementation barriers may include education and outreach to simplify complex practices, guidance on available site alternatives, and directing growers to available public funding and technical resources. Significant technical or economic barriers to implementation of protective practices are beyond the scope of the KRWQC to address directly. In these cases partner agencies and research institutions will be relied on to develop appropriate resources for implementation or simplify applicable practices.	The greatest motivator of adoption has been shown through our collaborative work to be crop yield and quality, and the greatest barriers are uncertainty due to lack of information and cost. We are working with partners such as NRCS and CSU Fresno's CIT to significantly improve the capacity to train advisors, growers, and those working for growers in the operation of drip and microspray irrigation and fertigation equipment. CDFA has funded development of curriculum already. Adapting and deploying this curriculum widely in the Central Valley with NRCS' collaboration and support is a high priority. Through such programs, it may also be possible to reduce some of the initial cost barrier through cost sharing with growers.	A summary of the MPEP study to assess barriers to adoption of practices is provided in Section 2.3.3 and Attachment G. Adapting and deploying curriculum in the operation of drip and microspray is ongoing.
5.3.2.3	Technically and Economically Feasible Practices	45/147	Coalition Outreach	The KRWQC will continue to support grower efforts to implement protective practices through outreach and support in conjunction with the SSJV MPEP.	The MPEP works with coalitions to reach out to growers at coalition, commodity group, professional, and other industry events, and to reach growers and advisors through a website that includes numerous tools and resources designed to help growers identify and understand protective practices. Many of our partners contribute similarly. One collaborator we are focused on is Michael Cahn, the developer of CropManage, an evolving decision-making platform to help growers combine operational information with climatic, crop, and soils data to guide daily irrigation and fertigation decisions. It is being adapted for use by almond, pistachio, and tomato growers, and can be expanded further across other crops, and with additional useful information for growers.	Outreach activities are described in Section 2.4, Appendix H, and Appendix I.
5.3.3.1	CGQMP & SSJV MPEP Outreach Approach	46/147	Coalition Outreach	Ongoing education will provide feedback on analysis of member surveys including relevant performance metrics (such as A/R and Farm Evaluation Surveys), and the findings of the SSJV MPEP regarding protective practices. The KRWQC will coordinate with the SSJV MPEP to define outreach curricula reflecting protective management practices throughout the CGQMP area.	NMP and Farm Evaluation information from the 2016 and 2017 reporting periods has been analyzed. It is being reviewed relative to potential water quality implications with growers, both directly, and through commodities groups and grower advisors.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
5.3.3.2	Outreach Activities and Tools	47/147	MPEP Collaboration	CGQMP outreach activities will leverage ongoing outreach programs conducted by partner groups (UCCE, USDA/NRCS, CSU, CDFA, and commodity groups) and Central Valley Water Quality coalitions in coordination with the SSJV MPEP. This network of cooperating partners will assist in the development and delivery of CGQMP relevant curricula, resulting in the optimal use of resources. KRWQC outreach events will include presentations of applicable grower feedback, and early implementation curricula from the SSJV MPEP. Developed curricula and educational material will be hosted online by the SSJV MPEP to streamline outreach and promote grower access.	Extensive resources, tools, learning event information, etc. are hosted on the MPEP website. Additional site-specific tools, including ET viewers and the SWAT Results Viewer, are developed and hosted by the MPEP, and accessible to members through their coalition websites. Additionally, please see 5.3.3.1 and 5.3.2.3.	Outreach activities are described in Section 2.4, Appendix H, and Appendix I.



## Section Two: Management Practices Evaluation Program

Comprehensive Groundwater Quality Management Plan Annual Report

Section Number	Section Title	Page Number	Category of Proposed Action	CGQMP Text	Corresponding MPEP Activity	Corresponding Section of MPEP Annual Update
5.3.3.2	Outreach Activities and Tools	48/147	MPEP Collaboration	The SSJV MPEP will help to coordinate partner meetings where information on protective practices will be provided. The KRWQC will seek to document growers' participation in these events. The SSJV MPEP maintains an online database of outreach and outreach-related activities. Events may be hosted by coalitions and/or cooperating partners. This allows the SSJV MPEP team and member coalitions to track grower participation in outreach activities.	The MPEP is proceeding as indicated, participating in about 2 outreach events per month, including some coalition-hosted events.	Outreach activities are described in Section 2.4, Appendix H, and Appendix I.
5.3.4.1	Timetable to Identify & Implement Management Practices	49/147	MPEP Collaboration	Year 1 <ul style="list-style-type: none"> <li>- Define baseline of protective practices currently implemented throughout the HVA and high priority areas. Develop summary statistics by soil, crop, and associated practices (e.g., March 2016 Farm Evaluations).</li> <li>- Coordinate with SSJV MPEP Team on research of known protective practices and schedule winter outreach curriculum.</li> </ul>	MPEP is supporting coalitions with outreach curriculum after reviewing Farm Evaluation results.	Outreach activities are described in Section 2.4, Appendix H, and Appendix I.
5.3.4.1	Timetable to Identify & Implement Management Practices	49/147	Data Evaluation & Reporting	Year 2 <ul style="list-style-type: none"> <li>- Begin tracking trends in the implementation of protective practices over time throughout the HVAs. Develop summary statistics by soil, crop, and associated practices (e.g., 2016-2017 Farm Evaluations).</li> <li>- Define baseline analysis for reported nitrogen applied versus crop yield (A/Y), calculate nitrogen removal values for crops with available nitrogen removal coefficients (to convert A/Y to A/R Ratios, see Sec 6.1.2.1). Develop summary statistics, box and whisker plots by soil, crop, and associated practices. Identify statistical outliers from the NMP Summary Report data.</li> <li>- Provide feedback to growers on their NMP Summary Report data and Farm Evaluation Surveys relative to other growers within similar cropping systems. Initiate specific outreach to outliers, as necessary. SSJV MPEP Team begins investigation of prioritized crops and site conditions with ongoing refinement of SWAT modeling to evaluate effects of management practice application.</li> </ul>	MPEP is reviewing NMP and Farm Evaluation results with coalitions, and providing agronomic assessment of NMP information that coalitions can use in outreach and feedback to growers, with MPEP support as needed.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
5.3.4.1	Timetable to Identify & Implement Management Practices	49/147	Data Evaluation & Reporting	Year 3 <ul style="list-style-type: none"> <li>- Continue tracking trends and progress in implementation of protective practices over time throughout the HVA and high priority areas. Develop summary statistics by soil, crop, and associated practices (e.g., 2016-2018 Farm Evaluations).</li> <li>- Begin tracking A/Y trends, calculate nitrogen removal for crops with available nitrogen removal coefficients to develop A/R ratios (as discussed in Section 6.1.2.1).</li> <li>- Develop summary statistics, box and whisker plots by soil, crop, and associated practices. Identify statistical outliers from the NMP Summary Report data.</li> <li>- Provide feedback to growers on their relative performance within similar cropping systems based on provided nitrogen application data and farm practices. Initiate specific outreach to outliers, as necessary.</li> <li>- Coordinate outreach and education to growers incorporating SSJV MPEP Team resources and findings of site specific modeling results demonstrating impact of implemented practices.</li> <li>- Integrate grower reported data as a SWAT modeling parameter inputs for the SSJV MPEP to analyze landscape-level trends and demonstrate progress. Assess landscape level modeling alongside long term groundwater monitoring data.</li> </ul>	NMP results have been integrated as a SWAT modeling parameter. They inform the N rates in the initial 4 modeling scenarios, and will be consulted in the development of subsequent scenarios. SWAT results will also be used as part of the outreach effort.	The SWAT assessment is described in Section 2.2.2, Appendix C, and Appendix D.
5.3.5	Performance Goals	50/147	Coalition Outreach	KRWQC members will be provided feedback on their reported information with respect to trends over time and relative to other growers. The KRWQC will conduct specialized outreach to members that appear to be statistical outliers with respect to nitrogen reporting and/or practice implementation.	See 5.3.4.1.	See 5.3.4.1.



## Section Two: Management Practices Evaluation Program

Comprehensive Groundwater Quality Management Plan Annual Report

Section Number	Section Title	Page Number	Category of Proposed Action	CGQMP Text	Corresponding MPEP Activity	Corresponding Section of MPEP Annual Update
5.3.5	Performance Goals	50/147	Coalition Outreach	The KRWQC will work with growers to receive feedback on implementation progress as additional protective management practices are identified by the SSJV MPEP and other independent studies.	See 5.3.4.1. Results of special studies are available to coalitions to support outreach.	See 5.3.4.1.
5.3.5	Performance Goals	51/147	Coalition Outreach	Grower receptivity and comprehension to outreach topics will be assessed by surveying a representative population of participating growers about the benefit of outreach and recommendations of areas for improvement. Survey results will be used to adjust and/or supplement outreach curricula and to follow up with participants, as necessary.	MPEP is available to support coalitions with this activity. Results are shared and folded into curricula.	A summary of the MPEP study to assess what prevents some growers from adopting practices is provided in Section 2.3.3 and Attachment G. Additional surveys of a representative grower population are ongoing.
5.3.5	Performance Goals	51/147	Coalition Outreach	Performance will be evaluated by the proportion of members reporting improved understanding, and where necessary, increased implementation of protective management practices.	MPEP is available to support coalitions with this activity.	Not yet applicable
5.3.5	Performance Goals	51/147	Coalition Outreach	Where possible, KRWQC outreach will also be assessed to determine if educational barriers to the implementation of appropriate management practices were adequately addressed.	MPEP is available to support coalitions with this activity.	Not yet applicable
6.1.1	Farm Evaluation Surveys	53/147	Data Evaluation & Reporting	The KRWQC will summarize these practices in an annual CGQMP update.	MPEP is available to support coalitions with this activity.	Not yet applicable
6.1.2	Nitrogen Management Plans	53/147	Data Evaluation & Reporting	To evaluate the trends in nitrogen use reported in the NMP Summary Report, the KRWQC will report the ratio of applied nitrogen (A) to nitrogen removed (R), the A/R metric recommended by the SWRCB-AEP.	MPEP is available to support coalitions with this activity. Agronomic analyses are available as context.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
6.1.2	Nitrogen Management Plans	53/147	MPEP Research	The Central Valley Water Quality Coalitions have contracted with Dr. Daniel Geisseler, University of California Department of Land, Air, and Water Resources CE Nutrient Management Specialist, to develop yield-to-removal (Y-to-R) conversion calculations/coefficients for 99% of the crops grown in the Central Valley. This work should address most of the knowledge gaps that were identified by the NMP TAWG, as described in the "Work Plan for Crop Nitrogen Knowledge Gap Study Plan and Guidance Documents" that was submitted by the CV Coalitions to the CVRWQCB on July 29, 2016.	The initial coefficients are currently in use and refinement of several is in progress. Once coefficients are revised, they will replace those in current use.	The development of Y-to-R conversion calculations/coefficients is described in Section 2.3.1. The initial coefficients are described in a report in Appendix E. A report summarizing progress towards refined coefficients is described in Appendix F.
6.1.2	Nitrogen Management Plans	53/147	Data Evaluation & Reporting	As Y-to-R conversions become available, the coalition will calculate A/R ratios from grower reported A/Y ratios. In addition to reporting A/R to the CVRWQCB, they will be shared with growers as an outreach and education tool.	MPEP supplements coalition feedback with agronomic assessment of NMP information.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
6.1.2	Nitrogen Management Plans	53/147	MPEP Research	<b>The sequence of Dr. Geisseler's activities is as follows:</b> <ul style="list-style-type: none"> <li>• <b>Task 1: Development of Y-to-R conversions for the 17 crops in the CDFA FREP database.</b></li> </ul>	These tasks were completed in 2016, resulting in usable coefficients for 71 crops. The current project is to refine coefficients for about a dozen others, and to provide new coefficients for perennial tissues of about half a dozen perennials.	The development of Y-to-R conversion calculations/coefficients is described in Section 2.3.1. The initial coefficients are described in a report in Appendix E. A report summarizing progress towards refined coefficients is described in Appendix F.





## Section Two: Management Practices Evaluation Program

Comprehensive Groundwater Quality Management Plan Annual Report

Section Number	Section Title	Page Number	Category of Proposed Action	CGQMP Text	Corresponding MPEP Activity	Corresponding Section of MPEP Annual Update
6.1.2	Nitrogen Management Plans	53/147	MPEP Research	<ul style="list-style-type: none"> <li>• <b>Task 2: Identification of crops not included in the CDFA database that are grown on major Central Valley acreage.</b> Ultimately, this work will develop Y-to-R values for 99% of the crop acreage in the Central Valley (not including non-alfalfa hay and silage).</li> </ul>	See 6.1.2.	See 6.1.2.
6.1.2	Nitrogen Management Plans	53/147	MPEP Research	<ul style="list-style-type: none"> <li>• <b>Task 3: Development of Y-to-R conversions for the additional crops that are not currently in the CDFA FREP database.</b></li> </ul>	See 6.1.2.	See 6.1.2.
6.1.2	Nitrogen Management Plans	53/147	MPEP Research	<ul style="list-style-type: none"> <li>• <b>Task 4: Assessment of the quality of the data as well as a description of additional work that will be needed to develop usable Y-to-R conversions for 99% of the crops grown in the Central Valley.</b></li> </ul>	See 6.1.2.	See 6.1.2.
6.2.1	Monitoring Grower Trends	54/147	Data Evaluation & Reporting	The cornerstone of the ILRP is reconciling and tracking information provided in Farm Evaluation Surveys and NMP Summary Reports. The Coalition will track this information over the long term and attempt to establish a relationship between implemented practices and reported nitrogen applications for similar site conditions. This information will be shared with growers and will be one method to monitor management practice trends of KRWQC growers. This information will also be analyzed as a component of the SSJV MPEP and GTM Program.	MPEP is available to support coalitions with this activity. Agronomic analyses are available as context.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
6.2.2	SSJV MPEP Analysis	55/147	MPEP Research	This assessment will occur along with priority investigations to define performance on specific sites. Iterative SWAT modeling using the available and appropriate data will be utilized to gauge the performance of implemented practices throughout the SSJV. Each iteration of SWAT model processing and output will be successively refined as new data and better information becomes available.	Initial SWAT modeling has been completed and results are being summarized. They will also be available to coalitions and growers in a SWAT Results Viewer.	The SWAT assessment is described in Section 2.2.2, Appendix C, and Appendix D.
6.3	Validate KRWQC Outreach Approach	56/147	Coalition Outreach	Grower comprehension and the effectiveness of outreach will be assessed to refine subsequent outreach. The goal is to continually improve grower outreach to maximize the benefits to KRWQC growers and the increased implementation of protective management practices, as necessary. This work is expected to include surveys of growers at outreach events and mailings to assess and refine outreach.	See 5.3.5.	See 5.3.5.
7	Data Evaluation & Reporting	58/147	Data Evaluation & Reporting	After the NMP Summary Report data is received and summarized, A/R ratios will be calculated and reported annually. They will also form a long-term data set for summary and interpretation. Results will be shared with growers through outreach events to educate members regarding their own practices in the context of their peers. This information will be included in the Management Plan Status Report for the review of the CVRWQCB.	MPEP is available to support coalitions with this activity. Agronomic analyses are available as context.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.
7	Data Evaluation & Reporting	58/147	Data Evaluation & Reporting	The Management Plan Status Report will summarize the Farm Evaluation Surveys and NMP Summary Reports, as required by the General Order. The results will be summarized in box and whisker plots and grouped by similar crop and soil types within townships (or larger areas if a township contains too few fields to provide meaningful context). Spatial mapping at a township level will also be presented to assist in the analysis of implemented management practices.	MPEP is available to support coalitions with this activity. Agronomic analyses are available as context.	A description of the agronomic assessment of 2016/2017 NMP data is provided in Section 2.2.3.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

# 3 Actions to Address Groundwater Quality Objectives

Actions taken by the KRWQC to address groundwater quality objectives through the FE, NMP Summary Report, outreach, and monitoring are discussed below. The FE Template completion and submittals allow the Coalition to monitor farm-level and field-level management practices by members in high and low groundwater vulnerability areas. Information gathered reflects general farm practices, active irrigation and abandoned irrigation well information, as well as field-specific irrigation management, nutrient management, and sediment and erosion control practices. Implementation of management practices will be monitored over time to evaluate trends, as defined in the SSJV MPEP and the KRWQC CGQMP. Many of the management practices noted in the FE are protective of surface and/or groundwater quality. Coalition members will continue to be targets of substantial outreach to inform and drive discussions, considerations, and understanding of management practices protective of groundwater quality. Finally, a groundwater monitoring program has been implemented to evaluate long term trends in groundwater quality, reflective of potential impacts from agricultural practices.

## 3.1 Identification of potentially impairing and protective management practices

Management practices that are protective of groundwater are discussed in detail within the Management Practice Evaluation Program Workplan ([https://agmpep.com/mpep/wp-content/uploads/20170914\\_Final\\_SSJV\\_MPEP\\_Workplan.pdf](https://agmpep.com/mpep/wp-content/uploads/20170914_Final_SSJV_MPEP_Workplan.pdf)). A brief summary of the practices that have been effective in protecting groundwater include:

1. **Proper Wellhead Protection:** Wellhead protection practices are necessary to prevent the movement of contaminants into a well. Unprotected wellheads can transmit contaminants from the surface into groundwater. Proper wellhead protection and well maintenance includes casing inspection, watertight caps and/or seals, air vents, foundation investigation, slope away from wellhead, avoidance of standing water, good housekeeping practices, backflow prevention, pump tests and/or service, and water quality sampling. The SSJV MPEP Committee produced a fact sheet with a list of proper wellhead protection and well maintenance requirements ([https://agmpep.com/mpep/wp-content/uploads/Wellhead\\_Protection\\_V9.pdf](https://agmpep.com/mpep/wp-content/uploads/Wellhead_Protection_V9.pdf)) which includes additional information.
2. **Proper Destruction of Abandoned Wells:** Improperly abandoned or maintained wells can transmit contaminants from the surface to groundwater. A well is considered abandoned if it has not been used for over a year and there is no intent to operate the well again. All abandoned wells must be properly destroyed consistent with State law and County ordinances within a reasonable timeframe. Generally, destruction of an abandoned well includes an investigation to determine current well condition followed by filling/sealing of the well dependent on site conditions. The SSJV MPEP Committee produced a fact sheet on abandoned wells and inactive well requirements which is available here: [https://agmpep.com/mpep/wp-content/uploads/abandoned\\_wells\\_V9.pdf](https://agmpep.com/mpep/wp-content/uploads/abandoned_wells_V9.pdf).
3. **Account for Nitrate in Irrigation Water:** Nitrogen (Nitrate and Ammonium N) in groundwater used for irrigation and soils should be actively considered when planning fertilizer applications. In order to determine the amount of N supplied by irrigation water, water samples must be collected and





## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

analyzed by a certified laboratory. Growers must consider the amount of nitrate already available in their irrigation water source prior to purchasing and application. The N found in irrigation water and soils should reduce the overall N requirement for the crop. The SSJV MPEP Committee provides an Irrigation Water Nitrogen Contribution Calculator online to assist growers in determining the N in applied irrigation water: <https://agmpep.com/calc-irrn/>.

4. Drip/microsprinkler irrigation: Drip and microsprinkler irrigation practices are characterized by lower rates of water application and the ability to match applied water to actual crop usage, thus minimizing leaching of water below the root zone. Changing irrigation practices to drip or microsprinkler reduces the movement of salts and/or nitrates from the soil surface to the underlying groundwater.
5. Split applications of fertilizers: Growers time fertilizer applications to crop needs which results in reduced loading to the soil profile as excess N is not contained within the root zone (uptake and utilization is faster). Agricultural studies reveal a point of maximum economic yield which differs from maximum yield. Maximum economic yield is the point in which additional yield obtained from more fertilizer is no longer justified by the associated production costs (material, labor, pest control, etc.) involved. These considerations have resulted in growers reducing their nutrient inputs or modifying the time and methods of inputs to match crop need which will ultimately result in decreases in nutrient concentrations in groundwater.
6. Increased use of foliar fertilizers: Foliar fertilizers are applied at low rates, directly to leaves as needed.

Additional management practices to improve N fertilizer efficiency were discussed in Table 3.3 of the MPEP Workplan and are briefly discussed in Table 3-1.

**Table 3-1. Irrigation Practices and Considerations for Adoption**

Irrigation Practice	Considerations
System Performance Evaluation	Improves efficiency, limited providers
Flow Meters	Capital and maintenance costs, limited usage once installed
Pump Tests	Diagnose pumping issues, repair costs
Weather based Irrigation scheduling	Training, reliable data sources
Plant based Irrigation scheduling	Training, equipment costs
Soil moisture based Irrigation scheduling	Equipment costs, Training
Pre-plant irrigations	Water availability, cost, changes in crop prices/decisions
Surge irrigations	Limited adoption in this region due to flat lands
Throttled irrigations	Training, lack of infrastructure on most farms
Shorten irrigation runs	Equipment costs, leased lands
Flow uniformity in furrows	Covered under System Performance, Training
Grading Fields	Capital Costs
Conversion to drip/micro or sprinkler	Capital Costs



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

Irrigation Practice	Considerations
Monitor flow and pressure in system	Covered under System Performance, Training
Repair Leaks	Maintenance Costs, Training
Operate sprinklers in calm conditions	Logistical concerns
Pressure compensating emitters	Proper system design, capital costs
Proper lateral line lengths	Proper system design
Clogging	Maintenance Costs
Sub-surface drains	Capital Costs, disposal of drainage water
Backflow prevention	Capital Cost, Maintenance Cost
Cover Crops	Capital Cost, Management Practice compatibility
Deep Rooted rotation crops	Economic Considerations
Perennial crop rotation	Economic Considerations
Adjust N application based on soil tests	NMP Template, Testing Cost
Adjust N timing	Training
Adjust N application based on irrigation water	NMP Template, Testing Cost
Reduce N by changing application methods	Capital Costs, Management practices
Variable rate N application	Capital Costs
Delayed injection during fertigation	Training
N budget	NMP template
Controlled release fertilizers	Capital Costs, Training
Manure/Compost Application	Training, Testing Costs
Quick Incorporation of Manure	Training

The Soil and Water Assessment Tool (SWAT) model will use crop, soil, topographic, climate, and land management parameters to evaluate the influence of irrigation management practices. SWAT is a spatially distributed, continuous, daily-time-step, hydrological model developed by United States Department of Agriculture (USDA) Agricultural Research Services to predict the impact of crop/land management practices on water quality, sediment and agricultural chemical losses to the environment in watersheds with heterogeneous soils, land use, and management conditions. Inputs for weather, soil, topography, vegetation, and land management practices drive the various biophysical processes associated with water quality and movement, sediment transport, crop growth, nutrient cycles, pesticide fate, energy balance, chemical and microbial dynamics, and water impoundments. The landscape-level analysis will be conducted in three primary steps:

1. Initial SWAT models will be developed to characterize the potential ranges of N loading based upon readily available information.
2. SWAT models will be refined by comparison with the results of field studies and benchmark N balance and N surplus data. Specialized studies in collaboration with California Department of Food and Agriculture\Fertilizer Research and Education Program (CDFA\FREP), commodity groups, and UCCE complement and inform outreach and assessment efforts.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

3. Updated SWAT models will be used to evaluate the effects of actual and hypothetical levels of Best Management Practices (BMPs) implementation.

Strategies proven to be protective of groundwater through SWAT modeling and other MPEP activities will be communicated to members through outreach and education activities. Additional details of current SSJV MPEP Committee activities can be found in the Annual Update provided in Appendix A.

Other objectives and deliverables of the MPEP effort includes more accurate measurements of N removal for various crops, increased N use efficiencies through improved irrigation management, and a comprehensive understanding of the fate of N in the environment. Once sufficient characterization of the existing practices, crops, and soil conditions is completed, outreach emphasizing alternate practices for increased protection of groundwater will be conducted. The key is to improve management practices related to N and irrigation water application by exploring environmental and economic benefits to members. In order to improve the SWAT model including calibration, analysis, and results, the MPEP Team was provided KRWQC NMP Summary Report data as reported by the members. KRWQC and data from various other water quality Coalition's enhanced the calibration of the SWAT model for California growing conditions. Activities of the MPEP Team were identified in Appendix A of the CGQMP.

### 3.2 Evaluation and tracking of current management practices

Member submitted FE and NMP Summary Report data for years 2016 through 2018 were analyzed for information on irrigation wells, irrigation practices, irrigation efficiency practices, nitrogen management methods to minimize leaching past the root zone, and crops. Data obtained from the FE and NMP Summary Reports allows the Coalition to suggestion modifications to existing practices for both groundwater protection and overall farming efficiencies. Through the collection and assessment of the FE and NMP Summary Report data over time, the Coalition can analyze the necessity of modifications and improvements and the effectiveness of altering management practices through outreach and education with annual trend analysis. Current management practices are detailed below. A further evaluation of past and current management practices is detailed in the implementation and verification of protective management practices section.

Members identified active irrigation wells, abandoned irrigation wells, and observation/monitoring wells located on their farm. In total, 15,121 wells were identified, of which 14,704 wells are active irrigation wells, 380 are abandoned or destroyed wells, and 37 are monitoring wells.

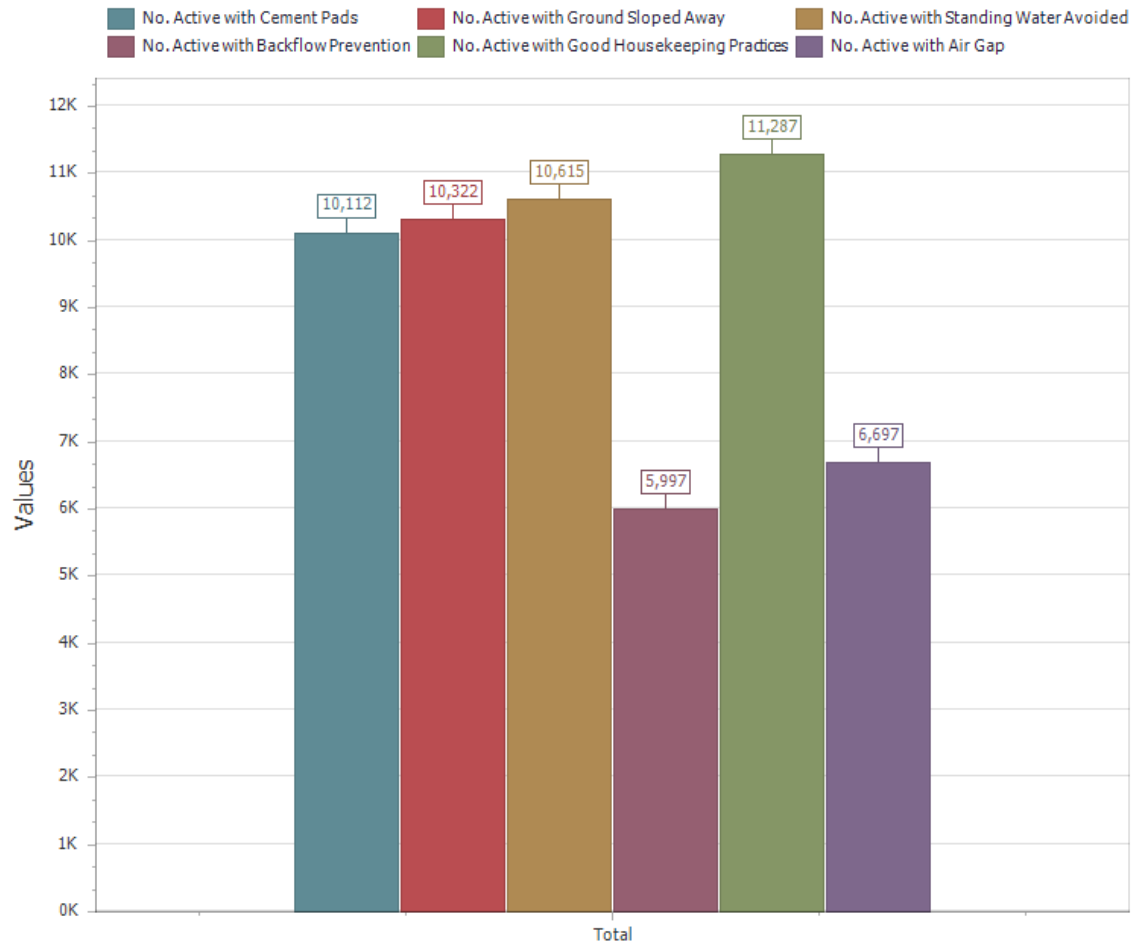
For the active irrigation wells, the member identified any wellhead protection measures in place. The wellhead protection measures (*of which the member identified all protection measures that apply to each well*) utilized by members within the KRWQC are set forth in Figure 3-1.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

### Irrigation Wellhead Protection Measures



**Figure 3-1. Irrigation Wellhead Protection Measures**

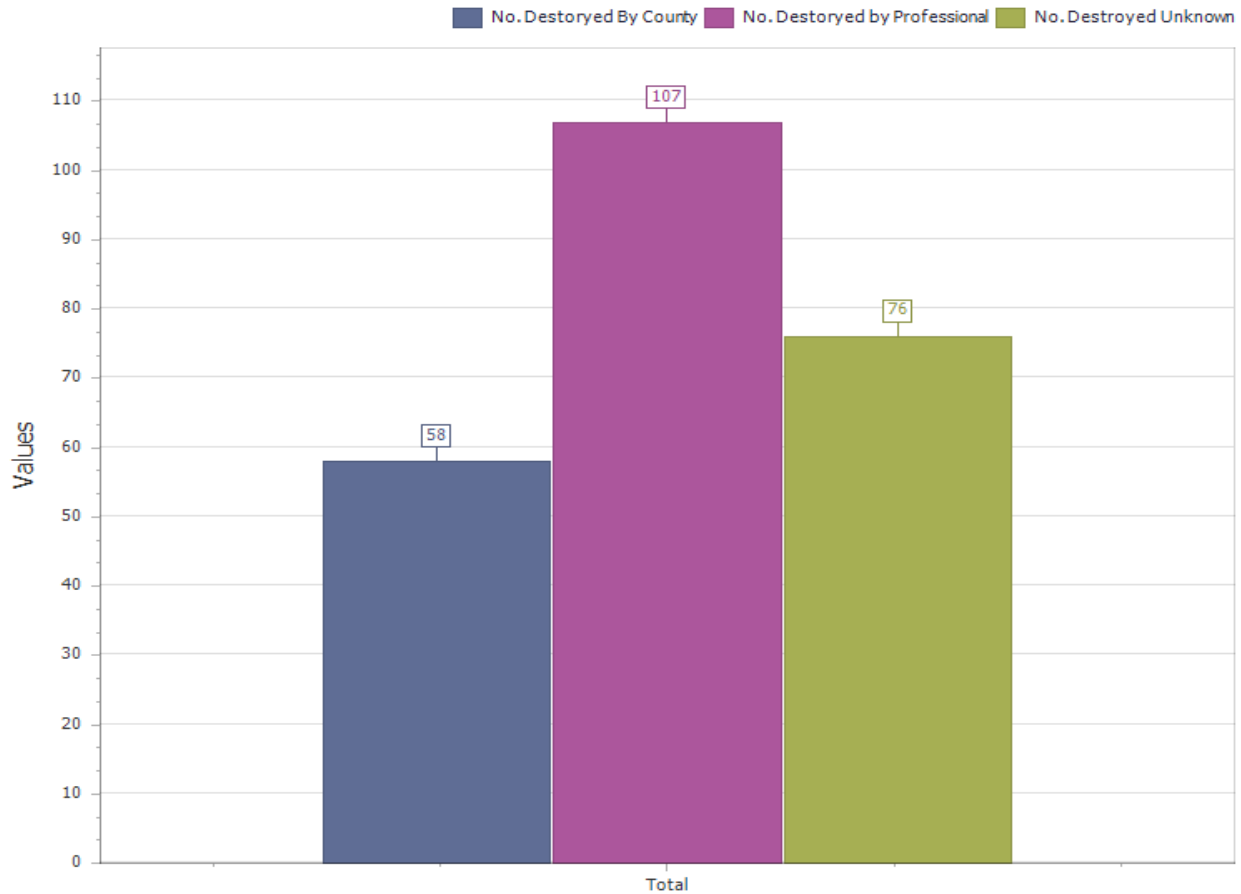
For the 380 abandoned or destroyed wells, the members within the KRWQC identified the method for which the well was destroyed as set forth in Figure 3-2. Wells destroyed with an unknown method may have been destroyed prior to owner management of the lands.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

### Abandoned Well Destroyed Method



**Figure 3-2. Abandoned Well-Destroyed Method**

Those members who identified a destroyed well will be cross checked with county records and verified as properly destroyed. Those members who did not identify a well destruction method will be contacted by the coalition to ensure proper destruction methods and groundwater protection measures were undertaken.

Irrigation practices are surveyed in part C, questions 2 and 3 of the FE. Members are required to report primary irrigation systems, secondary irrigation systems, and irrigation efficiency practices.

The primary irrigation practices on the 2018 Crop/Harvest Year FEs are presented in Figure 3-3. A total of 36.75% of total reported areas use drip irrigation, with the next largest proportion using border strip irrigation systems (23.17% of total reported acres). Altogether KRWQC has reported 49.03% of field acres employing surface irrigation, including border strip, furrow, and level basin flood irrigation systems. Pressurized irrigation systems (drip, micro-spray, and sprinkler systems) were reported on 47.23% of field acres. The remaining 3.74% of total reported acreage reported use of dry farming techniques or recorded the field as fallow.

A graphical representation of the 2018 Primary Irrigation Practices used within the KRWQC are provided in Figure 3-3.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

### Primary Irrigation Management Practices

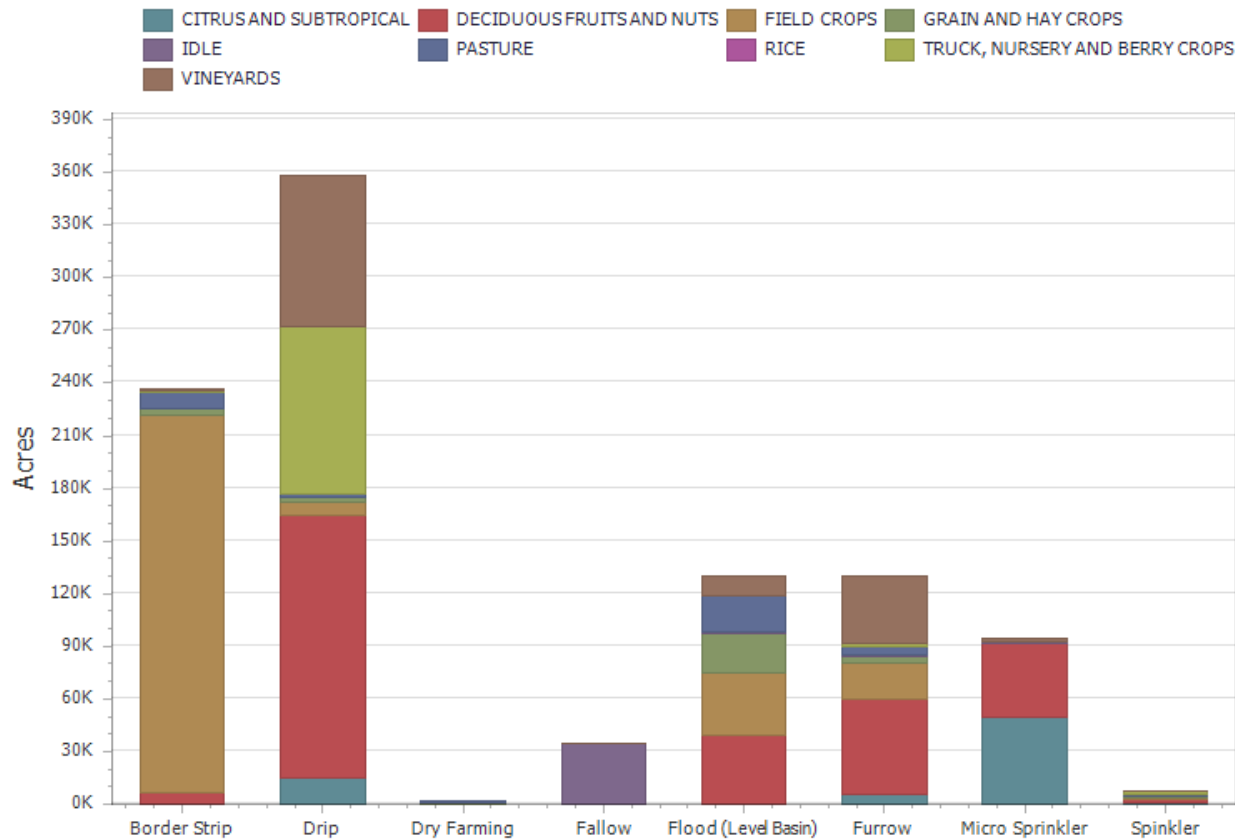


Figure 3-3. 2018 Primary Irrigation Management Practices

### 3.3 Education and outreach for members on management practices and impacts

Education, outreach, and other communication to members are critical components in the facilitation of change to management practices that are protective of groundwater. All Coalition growers have and will continue to be targets of substantial outreach to inform and drive discussions, considerations, and understanding of wellhead protection, destruction of abandoned wells, Nitrate in irrigation water, irrigation practices, and fertilizer applications.

As required by the General Order, the KRWQC conducted education and outreach events for enrolled grower members. Presentations included information on the completion and submittal of FEs, NMP worksheets and NMP Summary Reports, as well as self-certification training opportunities for the completion of NMPs. Education and outreach efforts continued to include outlining the requirements of the General Order, communicating the role of the KRWQC, supporting member compliance, describing the methodologies employed in the various technical reports developed by KRWQC, and assisting members in understanding and meeting the NMP Worksheet, NMP Summary Report, and FE reporting requirements.



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

The KRWQC conducted approximately 45 outreach events between 2016 and 2018. Multiple outreach events are scheduled each year in areas throughout the Coalition, and a video recording of the presentations and materials is available at the KRWQC website for members who cannot attend in person. The KRWQC Annual Monitoring Report includes more details on the previous year outreach events including PowerPoint presentations and materials provided to members. Past, current, and future outreach, education, and additional Coalition communications have included:

- Identification of High and Low Vulnerability Parcels (updated annually)
- Irrigation management practices protective of surface and groundwater
- Proper Wellhead Protection
- Proper Destruction of Abandoned Wells
- Nitrate Loading
  - Nitrate in Irrigation Water
  - Nitrate in Soil
- Irrigation practices protective of groundwater
- Split Fertilizer Applications
- Foliar Fertilizers
- NMP Summary Report Grower Analysis
  - Coalition-wide N application comparison of crops and soil types
  - N Removal Rates
  - Applied N divided by Yield (A/Y ratio)
  - Identification of anomalies and/or outliers
- Surveys

Additional details regarding annual Coalition specific outreach can be found in the Annual Monitoring Report. Ongoing MPEP outreach and education activities can be found in the MPEP Annual Report (Appendix A).

### 3.4 Implementation and verification of protective management practices

FE and NMP Summary Report data will be utilized to evaluate the pace of adoption for irrigation management practices identified as being protective to groundwater. The rate of implementation of protective practices will be evaluated based on reported changes in the FE and NMP Summary Report



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

analysis. Additionally, as needed, surveys and other methods will be used to verify protective management practices.

The Coalition will work with members to implement and fully adopt MPEP identified practices within a reasonable timeframe. Admittedly, external conditions (drought, groundwater and surface water supply variability, crop pricing, other unknown factors) will affect the rate of implementation, but the Coalition, through outreach, education, and communications efforts will work to accelerate implementation, particularly in the highest priority areas. The proposed time schedule for compliance focuses on immediate communication with members and will be commenced during the initial 6-year period, from the approval of the CGQMP, and will be implemented within the 10-year period set forth in the General Order. Tables 3-2 through 3-6 shows the KRWQC trends in groundwater protection practices from 2016 to 2018.

As shown in Table 3-2, the total number of abandoned wells in the KRWQC declined from 251 wells in 2016 to 241 wells in 2017 and increased again to 262 wells in 2018. The decline in reported abandoned wells from 2016 to 2017 could be related to clarifications at outreach events on the definition of an abandoned well or could be result of members not submitting reports. Future CGQMP communications and/or analysis will focus on accounts with abandoned well removals from the previous year.

**Table 3-2. Abandoned Well Data from Farm Evaluations 2016-2018**

Abandoned Wells		Destroyed		Destroyed-Professional		Other	
Year	Total	Count	Percentage	Count	Percentage	Count	Percentage
2016	251	95	37.8	76	30.3	80	31.9
2017	241	91	37.8	61	25.3	89	36.9
2018	262	86	32.8	66	25.2	110	42.0

Members cited the following reasons for failure to follow property well abandonment methods:

- **Insufficient Information:** Members were unaware of the County-specific well destruction or abandonment requirements. Outreach and educational activities by the Coalition have and will continue to address insufficient information for well abandonment practices. The Coalition will continue to strive to give Fresno, Kings, and Tulare counties the opportunity to present well destruction or abandonment requirements to Coalition members.
- **Costs:** The cost of professional services (water well contractors) and associated permits may be prohibitive for members. In order to reduce costs, members opt to cap or cover the well and remove any additional equipment which is not as comprehensive as the County-specific well destruction or abandonment requirements.

Wellhead protection practices with respect to irrigation wells on member property(ies) is emphasized heavily within the FE template. Areas of particular interest for well head projection practices include foundation (cement pad), slope (away from wellhead), standing water (to be avoided around wellhead), good “housekeeping” (keeping area around wellhead clean), air gap(s), and backflow prevention (check valve). As mentioned previously, the Coalition has and will continue to focus outreach efforts that focus on proper wellhead protection practices and county-specific well abandonment requirements. Table 3-3 shows the accumulated responses to the available categories of Wellhead Protection for those wells that are categorized as Abandoned. Table 3-4 shows the same categories for wells that are considered “Active.”





## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

**Table 3-3. Protective Practice Adoption Responses for Abandoned Wells, 2016-2018**

Abandoned Wells		Cement Pad		Ground Sloped Away from Wellhead		Standing Water Avoided		Good Housekeeping Practices	
Year	Total	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
2016	251	56	22.3	52	20.7	54	21.5	30	12.0
2017	241	57	23.7	51	21.2	53	22.0	26	10.8
2018	262	67	25.6	61	23.3	64	24.4	32	12.2

**Table 3-4. Protective Practice Adoption Responses for Active Wells, 2016-2018**

Active Wells		Cement Pad		Ground Sloped Away from Wellhead		Standing Water Avoided		Good Housekeeping Practices	
Year	Total	Count	Percent	Count	Percent	Count	Percent	Count	Percent
<b>Irrigation</b>									
2016	11,755	10,069	85.7	10,276	87.4	10,564	89.9	6,668	56.7
2017	13,391	11,442	85.4	11,621	86.8	11,988	89.5	7,504	56.0
2018	13,394	11,963	89.3	12,128	90.5	12,482	93.2	7,876	58.8
<b>Non-Irrigation</b>									
2016	129	89	69.0	88	68.2	95	73.6	47	36.4
2017	200	149	74.5	173	86.5	157	78.5	64	32.0
2018	223	172	77.1	164	73.5	178	79.8	72	32.3

Table 3-5 examines the KRWQC trends in testing for groundwater N content.

**Table 3-5. Grower Reported Responses to Nitrate-N Testing of Irrigation Water 2016-2018**

Test for Nitrogen in Irrigation Water		Yes		No	
Year	Total	Count	Percentage	Count	Percentage
2016	13,477	7,195	53.5	6,230	46.3
2017	16,166	8,539	52.8	7,613	47.1
2018	17,105	9,363	54.7	7,738	45.2

The majority of members (51-53%) employ high efficiency irrigation systems as a primary irrigation practice as shown in Table 3-6.

**Table 3-6. Primary Irrigation System, 2016-2018**

Irrigation Practice	Drip		Microsprinkler		Furrow		Flood	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
2016	4,210	31	2,671	20	3,796	28	1,828	14
2017	5,310	33	3,205	20	4,487	28	1,991	12
2018	5,717	33	3,496	20	4,544	27	2,119	12



## Section Three: Actions to Address Groundwater Quality Objectives

Comprehensive Groundwater Quality Management Plan Annual Report

### 3.5 Monitoring to determine if management practices are resulting in improved groundwater quality

A GQTM program (developed in conjunction with other coalitions) has been implemented in the Coalition to provide additional granular detail on water quality and potential shifts in Constituents of Concern (COC) concentrations. The coordinated development of a monitoring plan ensures that a large geographic region will be monitored consistently with similar quality control and reporting requirements. Groundwater monitoring is intended to be used to evaluate long term trends in groundwater quality, reflective of potential impacts from agricultural practices. However, collected data may reflect natural conditions associated with larger aquifer characteristics and potential influences from other sources (e.g., septic systems and other dischargers). Additionally, collected water quality data may reflect legacy impacts which are not from current agricultural land management practices

The General Order requires a GQTM Workplan to be submitted to the RWQCB one year following Groundwater Assessment Report (GAR) approval. The KRWQC submitted a GAR to the RWQCB on November 20, 2014. The RWQCB conditionally approved the GAR on April 26, 2016. The KRWQC submitted a GQTM Workplan to the RWQCB on April 26, 2017 and subsequent revisions on May 16, 2018 and July 31, 2018. The GQTM was conditionally approved by the RWQCB on August 21, 2018. The KRWQC sampled 80 wells in the fall of 2018. The monitoring network consisted of irrigation, domestic and public utility wells.

The General Order requires the GQTM network to include: the variety of agricultural commodities produced within the third-party's boundaries (particularly those commodities comprising the most irrigated agricultural acreage), 2) the conditions discussed/identified in the GAR related to the vulnerability prioritization within the third-party area, and 3) the areas identified in the GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply. Refer to Section 3 (Groundwater Monitoring Report) of the KRWQC's Annual Monitoring Report for expanded discussions on

- Groundwater Monitoring Objectives & Design
- Groundwater Monitoring Well Network
- Groundwater Trend Monitoring Sampling Timeline
- 2018 Groundwater Quality Results
- Groundwater Quality Assurance Evaluation
- Actions to Address Water Quality Exceedances

The 2019 GQTM Network consisted of 98 total active and non-active wells distributed throughout the KRWQC service area, excluding the Tulare Lake Bed region that has had the Municipal and Domestic (MUN) and Agricultural (AGR) supply beneficial use designations removed. Six wells have been removed from the GQTM Network for 2019 for the following reasons: (1) no electrical power, (2) pump out of service, or (3) sufficient wells in township range to warrant removal. Additionally, 7 new wells (not previously sampled) have been included in the 2019 GQTM Network which will result in 92 active wells for the 2019 GQTM Network. The KRWQC continues working diligently to identify potential wells in



## **Section Three: Actions to Address Groundwater Quality Objectives**

Comprehensive Groundwater Quality Management Plan Annual Report

---

underrepresented township\range designations. Sampling of the 2019 GQTM network was completed in June 2019 with results pending.

Hydrographs of each GQTM well will be produced showing (1) groundwater elevation (reported as Water Surface Elevation above or below Mean Sea Level), and (2) COC levels beginning with the third year of data. Hydrograph will be included in an Annual Report with the reporting of the 2020 GQTM Network results.



## 4 Recommendations and Conclusions

As previously discussed, the Coalition will evaluate the effectiveness of the CGQMP strategy through the actions, performances metrics, and goals as presented in Table 1-1. Details of the current status of the performance goals with recommendations and conclusions can be found below.

### 4.1 Outreach in High Vulnerability Areas

Submission requirements and timelines are dependent on groundwater vulnerability, surface water vulnerability, and farm size designations. The KRWQC GAR was submitted on November 20, 2014, and included evaluation of high and low vulnerability areas. The GAR was amended with updated High Vulnerability Areas (HVAs) on February 25, 2015. Members were informed of their vulnerability designation, farm size classification, and the required reporting schedules.

Annually, KRWQC members are mailed information packets which includes member parcels, vulnerability status, templates, submittal deadlines, and annual fees. All members were initially notified of parcel vulnerability status after the February 25, 2015 GAR amendment. Outreach meetings are scheduled beginning in October of each year and continuing in February. Members are given the opportunity to attend events at various locations within the Coalition boundary. Additionally, videos are available through the KRWQC web portal if the member is unable to attend an event in-person. Communications, both mail and email, are sent in September for the beginning of the invoice and reporting period. Members are sent status updates every two months after the initial September communication.

Sixty-three percent of KRWQC members attended outreach events in 2018. The Coalition intends to increase that attendance and outreach percentage with direct communication to members who did not attend an outreach event in 2018. Additionally, the Coalition will implement a monthly member communication update that includes status reports for submittals and attendance requirements. Further analysis will be completed through surveys to determine potential impedances (language, scheduling, etc.) for attending events.

### 4.2 Destruction of Abandoned Wells

Submitted FE data has allowed the Coalition to identify 182 members with approximately 262 abandoned wells. Due to limited information collected from the FE on irrigation and abandoned wells, the Coalition has extensive list of potential candidate APNs from member accounts, totaling over 1,300 parcels. The Coalition will be conducting additional outreach surveys with members indicating that they have abandoned wells on their property. Those members who identified a destroyed well will be cross checked with county records and verified as properly destroyed. Those members who did not identify a well destruction method will be contacted by the coalition to ensure proper destruction methods and groundwater protection measures were undertaken. Due to the additional information and outreach requirements, the Coalition anticipates providing a map with abandoned well locations in the next (2019) CGQMP Annual Report.

While the Coalition continues to discuss proper well abandonment requirements in annual outreach events, it is believed that a more aggressive outreach will assist in additional abandonment\destruction compliance. The Coalition will extend offers to County representatives for a more specialized member outreach in early 2020 focusing on well abandonment\destruction and wellhead protection. Flyers on proper destruction of abandoned wells and necessary wellhead protections will be included in the annual member packet to be sent



## Section Four: Recommendations and Conclusions

### Comprehensive Groundwater Quality Management Plan Annual Report

---

out in September 2019. Additionally, the Coalition will send out surveys on abandoned and destroyed wells to obtain clarifying details necessary for CGQMC updates.

### 4.3 Wellhead Protection

The Coalition continues to discuss proper well protection requirements in annual outreach events, but it is believed that a more aggressive outreach will assist in additional wellhead protection compliance. The Coalition will extend offers to County representatives for a more specialized member outreach in early 2020 focusing on well abandonment\destruction and wellhead protection. Flyers on proper destruction of abandoned wells and necessary wellhead protections will be included in the annual member packet to be sent out in September 2019. Additionally, the Coalition will send out surveys on wellhead protection to gain a better understanding on member compliance constraints.

### 4.4 Chemigation/Fertigation Practices

Chemigation is a method of irrigation wherein a pesticide is mixed with irrigation water before water application to the crop or soil. Chemigation is the application of pesticides through irrigation systems and is designed to prevent further pollution of groundwater from agricultural pesticides, if used according to application techniques with necessary backflow prevention devices. According to the California Department of Pesticide Regulation, chemigation is specified as a method of application for nearly 30% of the approximately 410 active ingredients contained in registered products in California, and on over 300 separate pesticide products. Approximately 24.8% of Coalition members are currently utilizing chemigation practices in their farming operations.

Fertigation is the injection of fertilizers through the irrigation system. Microirrigation systems are well-suited for fertigation because of water application control and frequency. Applying fertilizers through a microirrigation system allows uniform distribution in water application, flexibility in timing applications, and decreased fertilizer application compared to other methods. Approximately 64.6% of Coalition members are currently utilizing Fertigation practices in their farming operations.

The Coalition intends to take a proactive approach with respect to education and outreach of chemigation and fertigation practices. The first step will be a survey and educational materials about chemigation and fertigation practices delivered to all Coalition members. A review and understanding of potential operational constraints and limitations will help with the second step, educational outreach activities from technical advisors with expertise in chemigation and fertigation practices. Additionally, surveys, outreach, and technical workshops will be held on chemigation and fertigation practices as the Coalition and technical advisors deem necessary.

### 4.5 Nitrogen Outliers

As this is the third grower submission of NMP Templates to the KRWQC, the data was carefully evaluated for quality and outliers prior to analysis. Interquartile Range (IQR) summary statistical analysis was used to determine outliers for calculated Applied N over Removed N (A/R) values for each commodity group with respects to township and range, soil classification and irrigation practice. Quartiles are defined by taking the data sets, ranking the values, then defining the lower quartile (Q1) as the middle value for the first half of data points, the middle quartile (Q2) as the median of the data set, and the upper quartile (Q3) as the middle data point of the second half of the data set. The IQR is the fifty percent of the entire data set within Q1 and Q3, or Q3 minus Q1. Data points are determined as outliers if they were greater than one and half times the



## Section Four: Recommendations and Conclusions

### Comprehensive Groundwater Quality Management Plan Annual Report

---

upper IQR (or Q3), or one and half times less the lower quartile or Q1. For the purposes of the KRWQC NMP Summary, data points less than one and half times the Q1 were not identified as outliers, but similar to outliers, will be included in member outreach to determine if possible incorrect summary data was submitted to the coalition. Additional detail information on the NMP Summary is available in the KRWQC Annual Monitoring Report, Section 4.

Revisions adopted to the General Order in February 2019, require that the KRWQC propose an approach (by December 31, 2019) for defining a set of Members (outliers) with whom the third-party will follow up annually based on the new Irrigation and Nitrogen Management Plan (INMP) Summary Report data (AR data). Additionally, the revised General Order requires the Coalition to provide additional INMP self-certification training for Members notified as being outliers for report AR data and who opt not to use a specialist for INMP certification. The INMP self-certification training will focus on assisting Members in reducing their overall  $A/R_{3\text{ year}}$  ratio and will require in-person attendance. Members in KRWQC will first report their INMP Summary Report data for calendar year 2020.

The Coalition is currently analyzing submitted NMP Summary report data for years 2016-2018 to identify consistent outliers (if any). In order to accelerate outreach and education, the Coalition will send notifications with preliminary outlier status to members recommending attendance to an informational workshop with trained technical advisors to assist with Nitrogen management.

### 4.6 Conversion of Management Practices

The MPEP will be utilized to identify the effectiveness of management practices, where there is uncertainty regarding practice effectiveness under different site conditions, as previously discussed. Collection, application, and research on management practices that result in further protection of groundwater are goals of the MPEP activities. Further discussion on current and future MPEP activities can be found under the MPEP section of this Annual Report and Appendix A. The MPEP, CVGMC, and GQTM, in combination with outreach activities, provide the basis for improving surface management practices that will, eventually, result in improvements to groundwater quality. Grower adoption of protective management practices, where necessary, to protect groundwater, is the goal of the Coalition's outreach activities. Strategies proven to be protective of groundwater through SWAT modeling and other MPEP activities will be communicated to members through outreach and education activities. Once sufficient characterization of the existing practices, crops, and soil conditions is completed, outreach emphasizing alternate practices for increased protection of groundwater will be conducted. The key is to improve management practices related to nitrogen and irrigation water application by exploring environmental and economic benefits to members. The Coalition continues to communicate to Members via communications, newsletters, outreach, and educational about the most effective management practices for groundwater protection.



## 5 Bibliography/References

CDPR. 2019. *Chemigation Regulation Overview*. Sacramento, CA: California Department of Pesticide Regulation. Available at: <https://www.cdpr.ca.gov/docs/emon/grndwtr/chem/chemlegal.htm>. Accessed August 2019.

ITRC. 2003. *Chemigation and Fertigation Basics for California*. Davis, CA: Irrigation Training and Research Center. Available at: <http://itrc.org/reports/pdf/chemigationbasics.pdf> Accessed August 2019.

SSJV MPEP Committee. 2018. *Abandoned Wells and Inactive Wells*. Davis, CA: Southern San Joaquin Valley Management Practices Evaluation Program Committee. Available at: [https://agmpep.com/mpep/wp-content/uploads/abandoned\\_wells\\_V9.pdf](https://agmpep.com/mpep/wp-content/uploads/abandoned_wells_V9.pdf). Accessed August 2019.

SSJV MPEP Committee. 2017. *Final Management Practices Evaluation Workplan*. Davis, CA: Southern San Joaquin Valley Management Practices Evaluation Program Committee. Available at: [https://agmpep.com/mpep/wp-content/uploads/20170914\\_Final\\_SSJV\\_MPEP\\_Workplan.pdf](https://agmpep.com/mpep/wp-content/uploads/20170914_Final_SSJV_MPEP_Workplan.pdf). Accessed August 2019.

SSJV MPEP Committee. 2019. *Irrigation Water Nitrogen Contribution Calculator*. Davis, CA: Southern San Joaquin Valley Management Practices Evaluation Program Committee. Available at: <https://agmpep.com/calc-irrn/>. Accessed August 2019.

SSJV MPEP Committee. 2018. *Wellhead Protection & Well Maintenance*. Davis, CA: Southern San Joaquin Valley Management Practices Evaluation Program Committee. Available at: [https://agmpep.com/mpep/wp-content/uploads/Wellhead\\_Protection\\_V9.pdf](https://agmpep.com/mpep/wp-content/uploads/Wellhead_Protection_V9.pdf). Accessed August 2019.

UCANR. *Fertigation*. Davis, CA. University of California Agricultural and Natural Resources. Available at: <http://fruitsandnuts.ucdavis.edu/files/73697.pdf>. Accessed August 2019.



# Appendix A

## MPEP Annual Update